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B7B BSDA

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(54) **Collapsible steering column**

(57) A steering column tube for a motor vehicle capable of obtaining a superior energy absorption power in a car crash has energy absorbing plates 14 between a first end part of a first column tube member 12 and a second end part of a second column tube member 13. In each of the energy absorbing plates, a buckling adjusting part 15 is provided at a part of the inner-side piece of the energy absorbing plate so as to swell toward an outer-side piece 14c of the energy absorbing plate. For this reason, when a car crash gives an impact force to the first or second column tube member, the successive buckling of the energy absorbing plates is performed instantly, thereby enabling the absorbing amount of energy to be maximized under the limited load and displacement amount.

FIG. 1

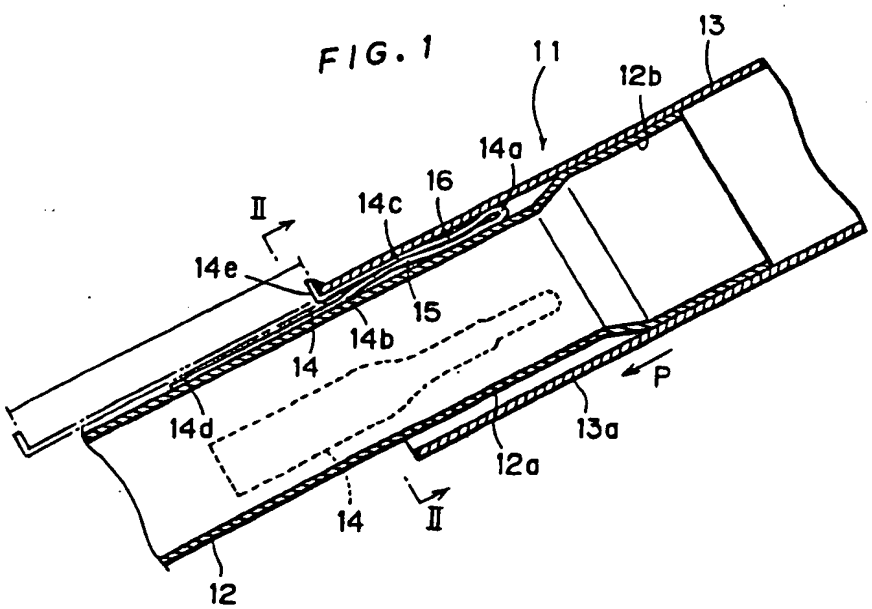

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FIG. 1

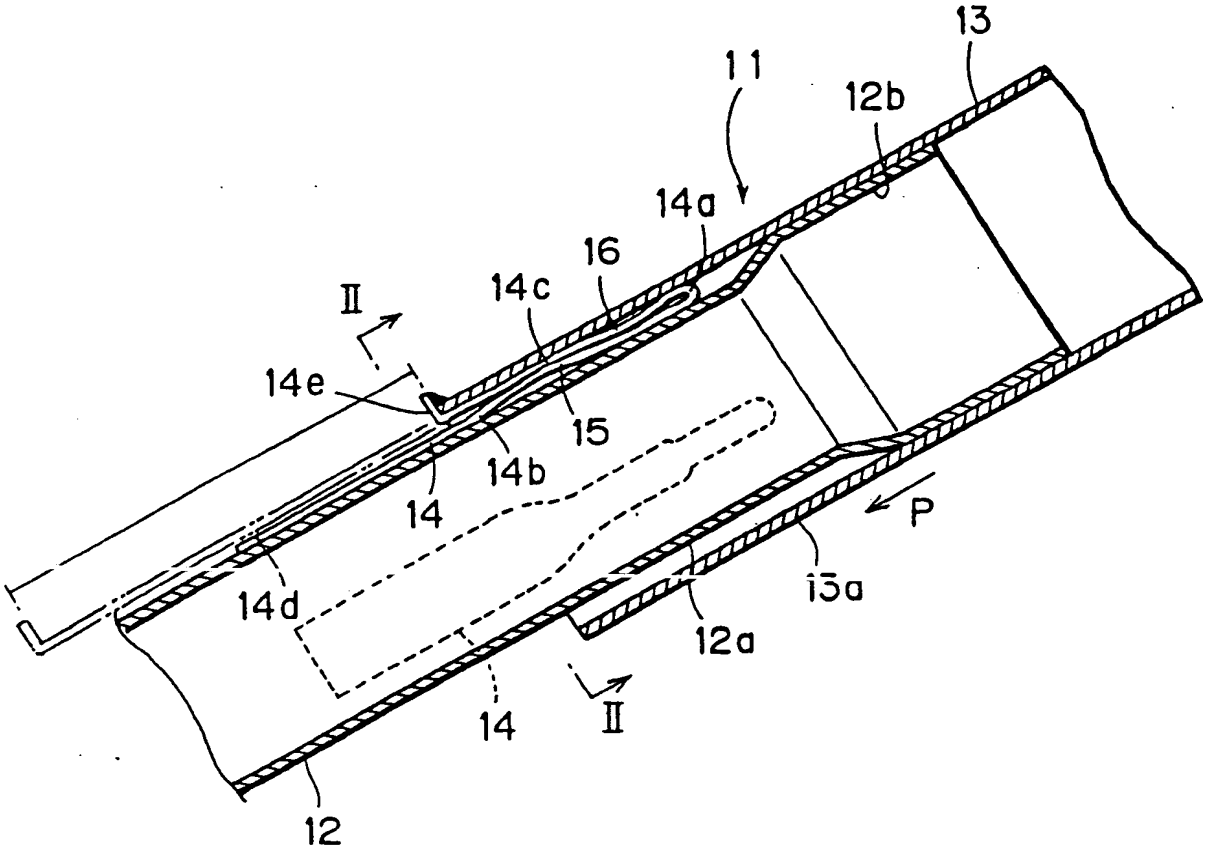

13
11
12b
14a
16
14c
II
14e
15
14b
14
14d
P
13a
12a
14
II
12

FIG. 2

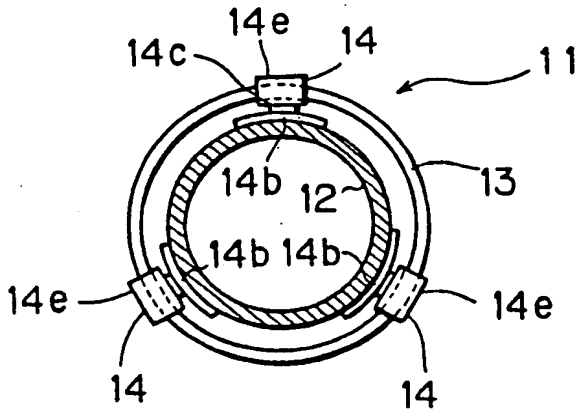

14e
14c
14
11
14b
12
13
14b 14b
14e
14e
14
14

FIG. 3

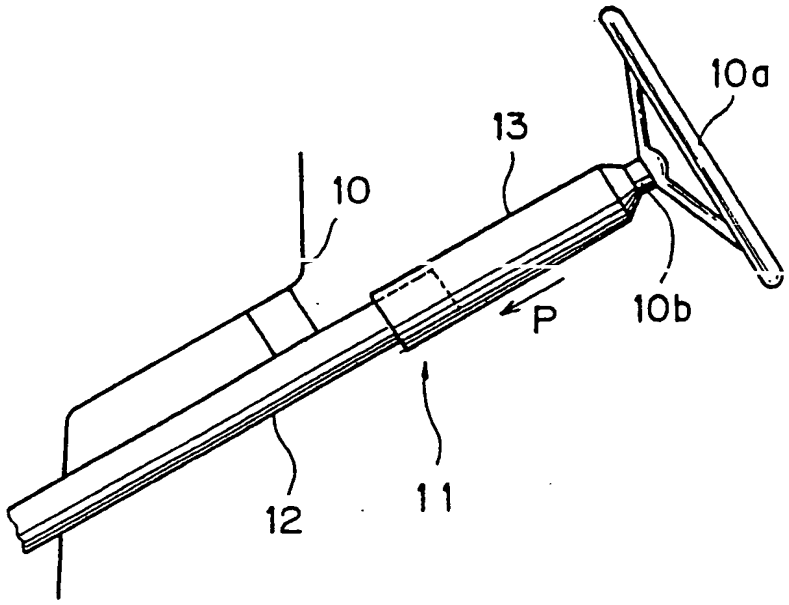


FIG. 6

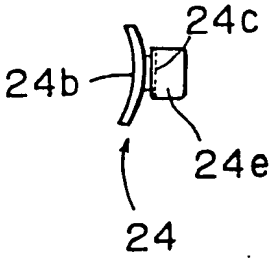


FIG. 4

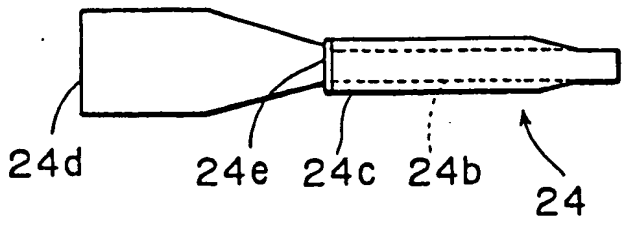


FIG. 5

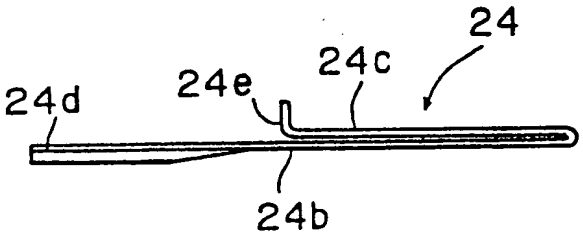


FIG. 7

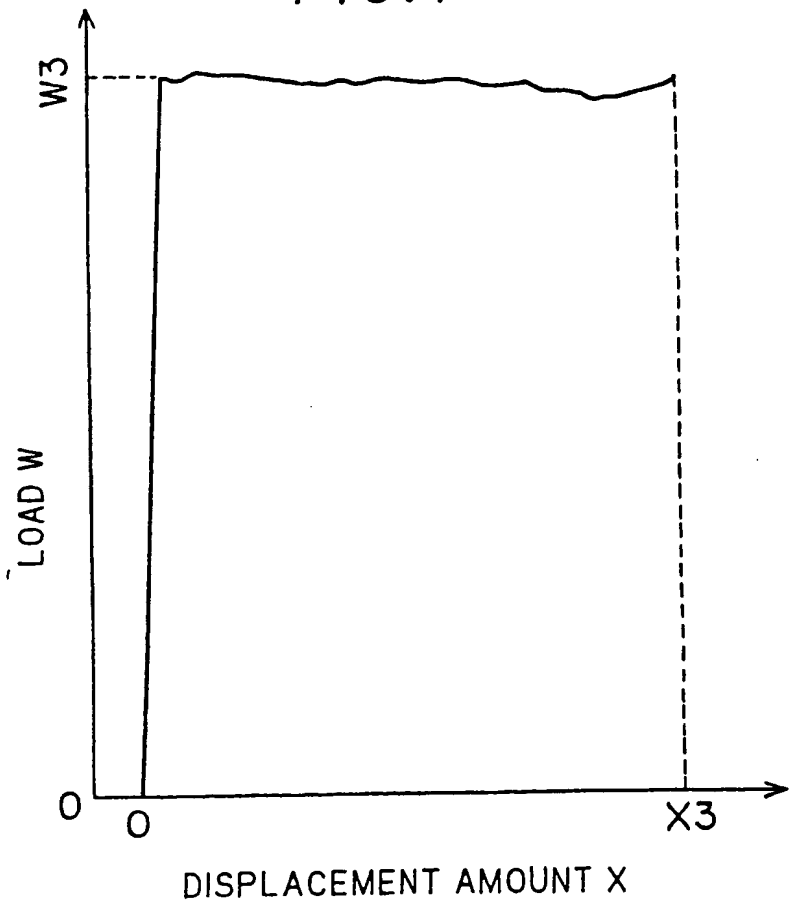


FIG. 8

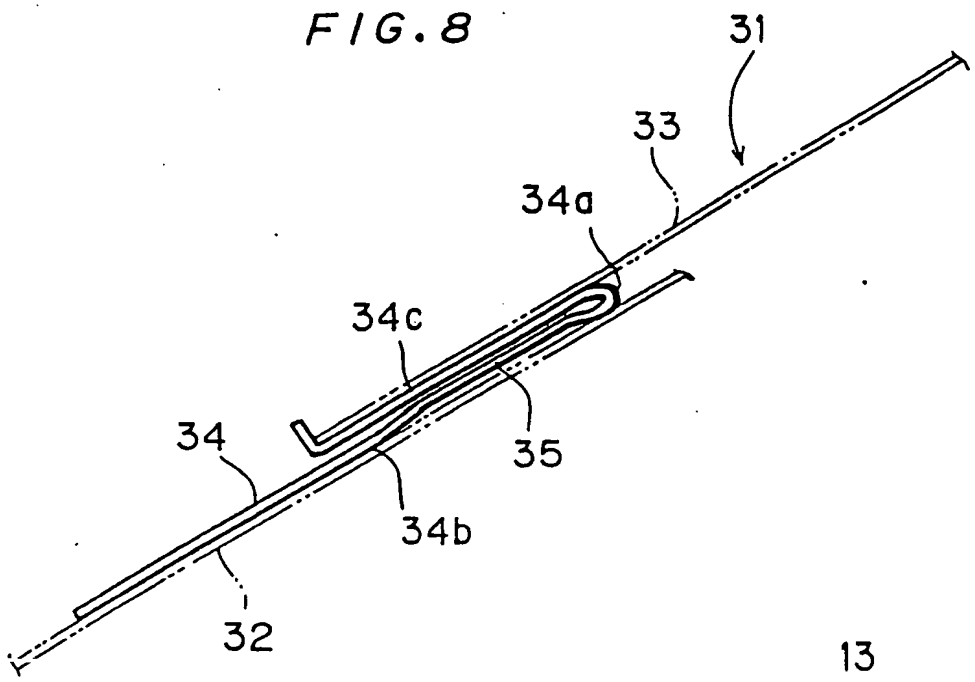


FIG. 9

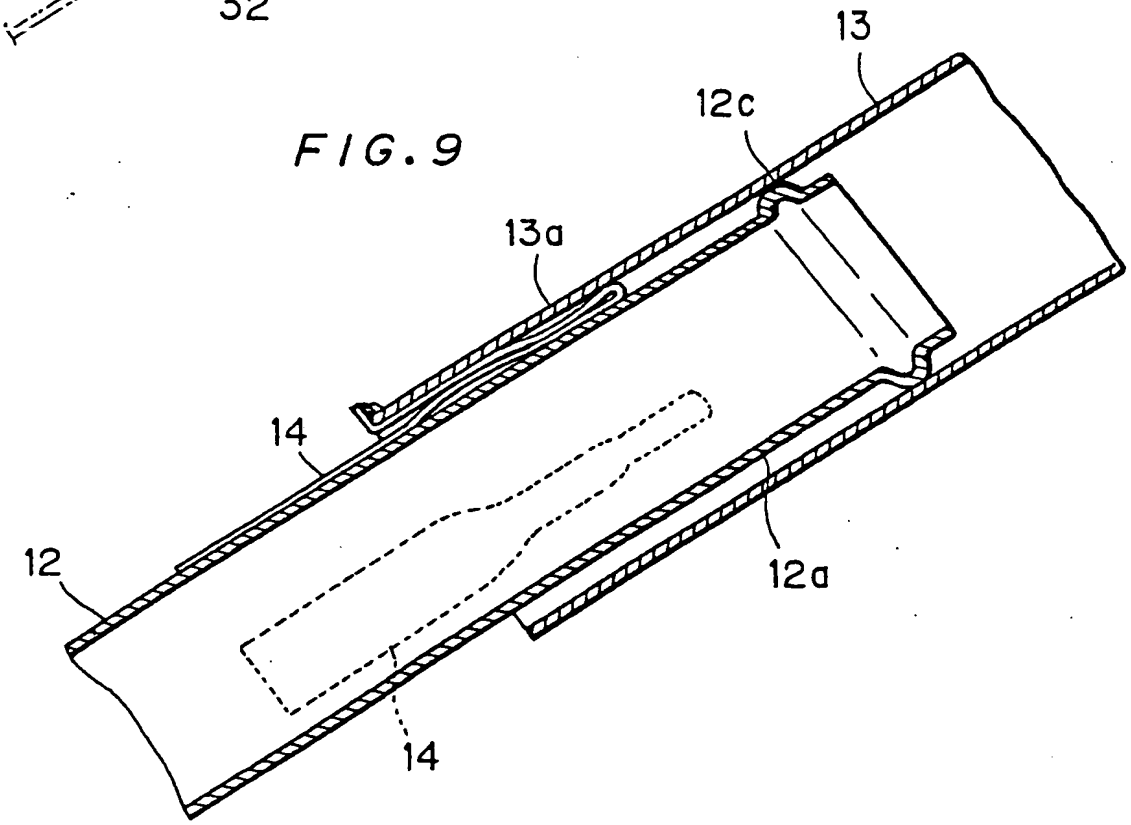


FIG. 10

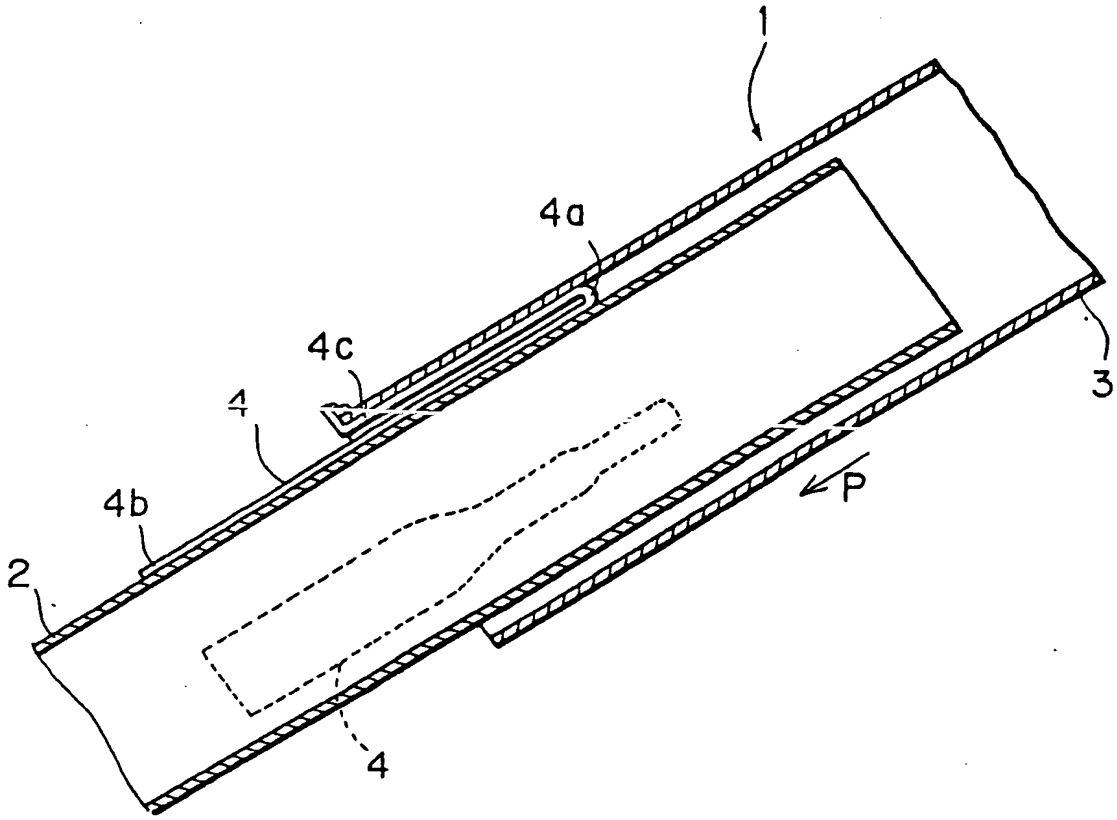


FIG. 11

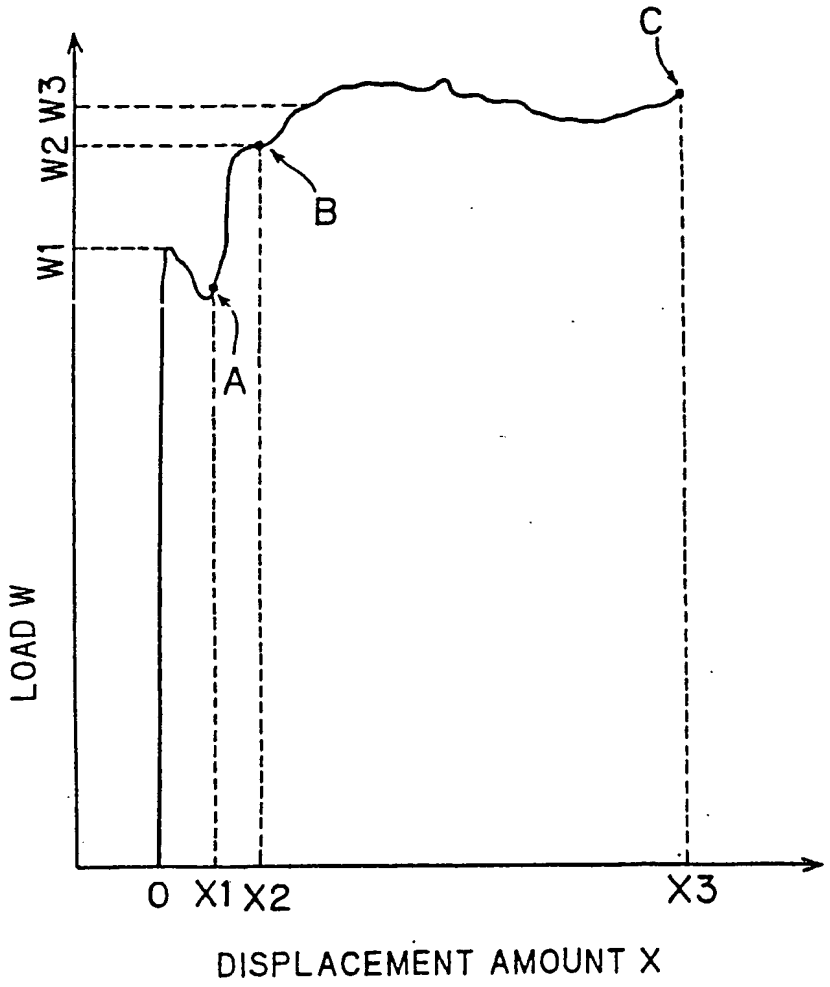


FIG. 12

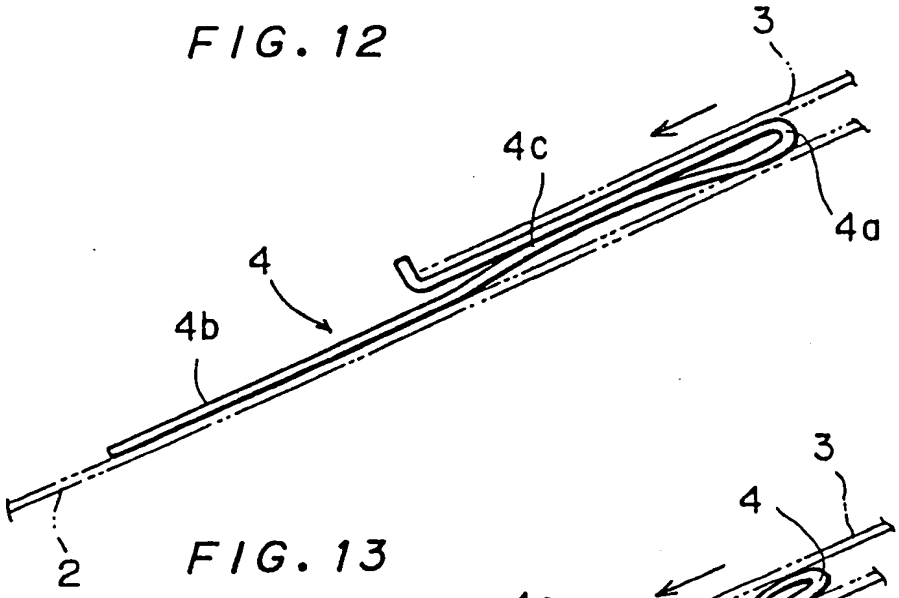


FIG. 13

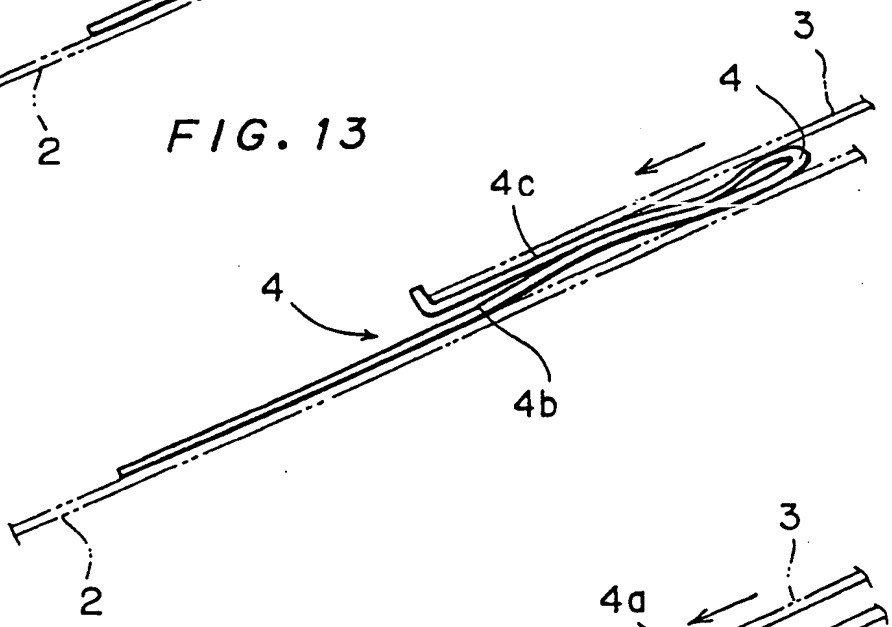
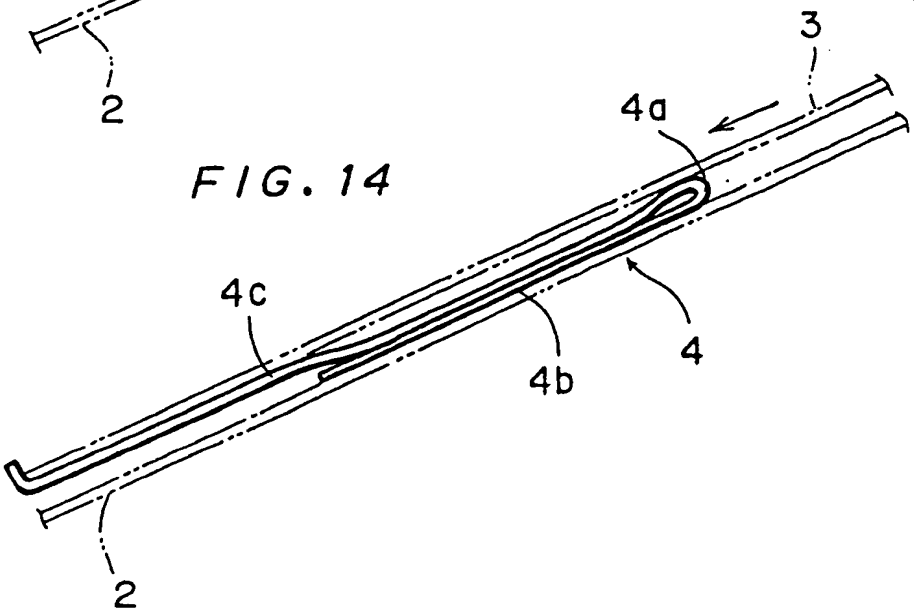


FIG. 14



TITLE OF THE INVENTION

Steering Column Tube for a Motor vehicle

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a steering column tube for a motor vehicle, more specifically the steering column tube for the motor vehicle capable of obtaining superior energy absorpsion power at a car clash.

Description of the Background Art

At a car clash, there may frequently take place an accident in which an inertia force accompanied by a running of a motor vehicle causes a driver to be thrown forward out of his driving position so that he knocks excessively his breast against a steering wheel.

Conventionally, a steering column tube has been developed in which, when the clash causes the driver to be severely knocked against the steering wheel, a compressive deformation of steering column tube along an axial direction takes place concurrently, thereby absorbing an impact force acting upon the driver.

Fig. 10 is a sectional view of a proposed example of a steering column tube 1 having the afore-mentioned energy absorption function. As shown in Fig. 10, the steering column tube 1 comprises a lower column tube member 2 which is fixed to a car body, an upper column tube member 3 has a

lower end part in which an upper end part of the lower column tube member 2 is inserted slidably, and a plurality of energy absorbing plates 4 which are disposed along a circum- ferential direction between both the members 2 and 3 with intervals being left therebetween.

Each of the energy absorbing plates 4 is formed by turning up an approximately central part of a flexible long member into an U-shaped state. Namely, it includes a folded part 4a, an inner-side piece 4b, and an outer-side piece 4c. The folded part 4a is located at the inside of the lower end part of the upper column tube member 3, and one end (a lower end) of the inner-side piece 4b is fixed to an outer peripheral face on the upper end part of the lower column tube member 2, while one end (a top end) of the outer-side piece 4c is fixed to the lower end part of the upper column tube member 3. A steering shaft (not shown) having a steering wheel (not shown) on its upper end side is inserted into the steering column tube 1, and the lower end part of the steering shaft is inserted into a steering gear box. If an impact force, incurred by knocking a body of the driver against the steering wheel at the car clash, is given to the upper column tube member 3 over the predetermined amount, the upper column tube member 3 is pushed in a direction of arrow P. In response to that, the inner-side piece 4b of the energy absorbing plate 4 is successively folded

outwardly from the vicinity of the folded part 4a toward the lower end side of the inner-side piece 4b so as to be successively buckled. At that time, the afore-mentioned impact energy is converted into a work necessary for the buckling, whereby the impact energy is absorbed.

Next, a relation between a load applied to the steering column tube 1 and a corresponding displacement amount thereof at the process of absorbing the impact energy is considered:

Fig. 11 is a graph showing the characteristics between the load W and the displacement amount X of the steering column tube 1. The vertical axis indicates the load W acting upon the steering column tube 1 and the horizontal axis indicates the displace amount (stroke) X along an axial direction thereof. For this reason, an amount of energy absorbed by the steering column tube 1 is defined by an area surrounded by a characteristic curve and an X axis of Fig. 11. Fig. 12 illustrates a deforming state of the energy absorbing plate 4 corresponding to a point A of Fig. 11, Fig. 13 illustrates a deforming state thereof corresponding to a point B of Fig. 11, and Fig. 14 illustrates a deforming state thereof corresponding to a point C of Fig. 11.

As shown in Fig. 11, when the impact force is given to the energy absorbing plate 4 from the upper column tube member 3, the energy absorbing plate 4 commences an initial

buckling. As shown in Fig. 12, the initial buckling is incurred by that a part of the inner-side piece 4b of the energy absorbing plate 4 is reduced such that the inner-side piece 4b, being pushed out outwardly, becomes in contact with the outer-side piece 4c. Such a buckling causes the steering column tube 1 to be displaced by X1 of the displacement amount.

When the load is further applied to the steering column tube 1, a secondary buckling takes place with the load of W2. As shown in Fig. 13, the secondary buckling is incurred by a deformation of such a part of the outer-side piece 4c as in vicinity of the folded part 4c, which is made such that the outer-side piece 4c is curved toward the inner-side piece 4b. The secondary buckling causes the steering column tube 1 to be displaced by X2 of displacement amount. Thus, when the load reaches W3, at last, the successive buckling of the inner-side piece 4b commences from a position in vicinity of the folded part 4a toward the lower end side of the inner-side piece 4b. After that, only if the load whose amount is approximately equal to W3 is kept to be applied to the steering column tube 1, the successive buckling thereof progresses. Thus, as shown in Figs. 11 and 14, the displacement amount reaches X3.

From a viewpoint of protecting the driver at the car clash, it is preferable that the energy absorption amount

based on the deformation of the steering column tube 1 is maximized. such an increase in the energy absorption amount is attained by setting the load W and the displacement amount X to be as large as possible. Acceleration of the displacement of the steering column tube 1 at the car clash is, however, restricted its upper limit so that it may be avoided that an excessive load acts upon the driver. The displacement amount X is also limited within the predetermined range from the requirements being imposed when designing the vehicle. For this reason, when developing the energy absorption structure of the steering column tube 1, a contrivance for making it possible to maximize the energy absorption amount under the afore-mentioned limited range of the load W and the displacement amount X becomes needed.

According to the energy absorption structure of the conventional steering column tube 1, however, the initial buckling and the secondary buckling occurs in the energy absorbing plate 4, as shown in Figs. 11 to 14 . Since, the loads W1 and W2 of the initial and secondary bucklings are smaller than the load W3 of the successive buckling, the conventional steering column tube 1 has a problem that an energy absorbing amount is decreased corresponding to the difference between the loads W1, W2 and the load W3.

SUMMARY OF THE INVENTION

The present invention is concerned with a steering

column tube for a motor vehicle, which includes: (a) a first column tube member having a first cylindrical end part; (b) a second column tube member having a second cylindrical end part into which the first cylindrical end part is slidably inserted; and (c) a plurality of flexible energy absorbing plates which are disposed along a circumferential direction between the first cylindrical end part and the second cylindrical end part with intervals being left therebetween. Besides, each of the energy absorbing plates includes: (1) an inner-side piece which is disposed on an outer peripheral face of the first cylindrical end part along an axial direction of the steering column tube and has an end fixed to the first cylindrical end part and another end disposed in the second cylindrical end part; (2) a folded part, extended from another end of the inner-side piece, which is outwardly turned up into a U-shaped state; (3) an outer-side piece, extended from a top end of the folded part, which is disposed on an inner peripheral face of the second cylindrical end part along the axial direction of the steering column tube and has a top end is fixed to the second cylindrical end part; and (4) a first buckling adjusting part being formed by deforming partially the inner-side piece in the second cylindrical end part such that the inner-side piece swells partially toward the outer-side piece.

Therefore, a principal object of the present invention is to provide a steering column tube for a motor vehicle which can maximize an energy absorbing amount under the limited load and displacement amount.

According to the steering column tube of the present invention, the energy absorbing plate, which is disposed between the first cylindrical end part of the first column tube member and the second cylindrical end part of the second column tube member, has the buckling adjusting part which is formed by partially curving the inner-side piece toward the outer-side piece. For this reason, when an impact force is given to the first column tube member or the second column tube member by a car clash, a successive buckling is performed instantly, thereby making it possible to maximize the energy absorbing amount under the limited load and displacement amount.

These and other objects, features, aspects and advantages of the present invention will become more apparent from the following detailed description of the present invention when taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a sectional view of the steering column tube according to a first embodiment of the present invention;

Fig. 2 is a sectional view taken from the line II-II of Fig. 1;

Fig. 3 is a schematic side view of the steering apparatus into which the steering column tube of Fig. 1 is incorporated;

Fig. 4 is a plan view of a member of constituting an energy absorbing plate which is applied to the first embodiment;

Fig. 5 is a front view of the member of Fig. 4;

Fig. 6 is a side view of the member of Fig. 4;

Fig. 7 is a graph showing the characteristics between a load and a displacement amount of the steering column tube according to the first embodiment;

Fig. 8 is a side view of an energy absorbing plate which is incorporated into a steering column tube according to the second embodiment;

Fig. 9 is a sectional view of the variant example of the steering column tube according to the second embodiment;

Fig. 10 is a sectional view of a conventional steering column tube;

Fig. 11 is a graph showing the characteristics between a load and a displacement amount of the conventional steering column tube; and

Figs. 12 to 14 are side views showing the states where the energy absorbing plate is deformed correspondingly

to each of predetermined points in Fig. 11.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Fig. 1 is a sectional view of a steering column tube for a motor vehicle according to a first embodiment of the present invention. Fig. 2 is a sectional view taken from the line II-II of Fig. 1. Fig. 3 is a schematic side view of a steering apparatus into which the steering column tube of Fig. 1 is incorporated.

As shown in Figs. 1 to 3, the steering column tube 11 of the embodiment includes a lower column tube member (a first column tube member) 12 being partially fixed to a car body 10, an upper column tube member (a second column tube member) 13 whose diameter is larger than that of the lower column tube member 12, and a plurality of flexible energy absorbing plates 14 which are disposed between both the members 12 and 13.

The lower column tube member 12 further includes a cylindrical guide member 12b at an upper end side thereof, and an outer diameter of the guide member 12 is approximately equal to an inner diameter of a lower end part (a second cylindrical end part) 13a of the upper column tube member 13. The guide member 12b and an upper end part (a first cylindrical end part) 12a of the lower column tube member 12 are slidably inserted into the lower end part 13a of the upper column tube member 13. In that case, an outer

peripheral face of the guide member 12b is in contact with an inner peripheral face of the lower end part 13a of the upper column tube member 13, whereby a movement of the upper column tube member 13 is guided along the axial direction of the steering column tube 11.

Three units of energy absorbing plates 14 are disposed while leaving equal intervals therebetween along the circumferential direction between the upper end part 12a of the lower column tube member 12 and the lower end part 13a of the upper column tube member 13.

Each of energy absorbing plates 4 includes a folded part 14a, an inner-side piece 14b, an outer-side piece 14c, a first buckling adjusting part 15 being provided on the inner-side piece 14b, and a second buckling adjusting part 16 being provided on the outer-side piece 14c. The inner-side piece 14b is disposed along the axial direction of the steering column tube 11 on the outer peripheral face of the upper end part 12a of the lower column tube member 12 and a lower end (an end) 14d of the inner-side piece 14b is fixed to the upper end part 12a of the lower column tube member 12 by means of welding, while an upper end (another end) thereof is disposed in the lower end part 13a of the upper column tube member 13. The folded part 14a, extended from the upper end of the inner-side piece 14b, is formed to be turned up outwardly into the U-shaped state. The inner-side

piece 14c, extended from a top end of the folded part 14a, is disposed along the axial direction of the steering column tube 11 on the inner peripheral face of the lower end part 13a of the upper column tube member 13 and a top end 14e of the inner-side piece 14c is fixed to a lower end part 13a by welding.

The first buckling adjusting part 15 is formed by deforming partially the inner-side piece 14b in the lower end part 13a of the upper column tube member 13 such that a part of the inner-side piece 14b swells toward the outer-side piece 14c. It is preferable that the buckling adjusting part 15 is in contact with the outer-side piece 14c. The second buckling adjusting part 16 is formed by deforming partially the outer-side piece 14c between the first buckling adjusting part 15 and the folded part 14a such that a part of the outer-side piece 14c swells toward the inner-side piece 14b. It is preferable that the second adjusting part 16 is also in contact with the inner-side piece 14b.

As shown in Fig. 3, a steering shaft 10b having a steering wheel 10a on its upper end part is inserted into the steering column tube 11, whose lower end part is inserted into the steering gear box (not shown).

The first and second buckling adjusting parts 15 and 16 are formed in the following manner: As shown in Figs. 4

to 6, first, a member 24 of constituting the energy absorbing plate, in which the first and second buckling adjusting parts 15 and 16 have not yet been provided, is prepared. A top end 24d of a longer piece 24b, which is intended to constitute the inner-side piece 14b, is fixed to the predetermined position of the lower column tube member 12, while a top end 24e of a shorter piece 24c, which is intended to constitute the outer-side piece 14c, is fixed to the predetermined position of the upper column tube member 13. After that, the upper column tube member 13 is pushed toward the lower column tube member 12 by the predetermined distance to perform a precompression. As a result, first, a deformation similar to the conventional initial buckling as shown in Fig. 12 occurs in the member 24 to form the first bucking adjusting part 15. Next, a deformation similar to the conventional secondary buckling as shown in Fig. 13 occurs in the member 24 to form the second buckling adjusting part 16.

After the first and second buckling adjusting parts 15 and 16 are formed by the precompression, the steering column tube 11 is mounted to the car body 10.

According to the present steering column tube 11, the first and second buckling adjusting parts 15 and 16 corresponding to the conventional initial and secondary bucklings as shown in Figs. 12 and 13 have been in advance

formed in the energy absorbing plates 4. For this reason, when the driver is knocked against the steering wheel 10a at the car clash and therefore the upper column tube member 13 is pushed in a direction of arrow P in Figs. 1 and 3, as shown in the characteristic graph of the load and displacement amount of the steering column tube 11 of Fig. 7, a successive buckling is performed instantly by the load of W3 without occurring the initial and secondary bucklings. Thus, the folded part 14a moves toward the lower end 14d of the inner-side piece 14b and finally the displacement amount reachs X3. During the displacement, the afore-mentioned impact energy is absorbed into the work of the successive buckling. In that case, since all the displacement of the steering column tube 11 is induced by the successive buckling, the load W taking place during the displacement thereof is maintained to be constant. Therefore, it is possible that the energy is effectively absorbed even at the commencement of the buckling, thereby enabling an absorbing amount of energy to be maximized under the limited load W and displacement amount X.

Fig. 8 is a sectional view of a energy absorbing plate 34 which is applied to a steering column tube 31 of a second embodiment according to the present invention. As shown in Fig. 8, a different point of the steering column tube 31 of the second embodiment from the one 11 of the

first embodiment will be described bellow. That is, in the first embodiment, the first and second buckling adjusting parts 15 and 16 of the steering column tube 11 is formed by the pre-compression. On the other hand, in the second embodiment, a buckling adjusting part 35 of the energy absorbing plate 34 is fomred by a press (hereinafter referred to as pre-press). Namely, under a state where the energy absorbing plate 34 has not yet been mounted to a lower column tube member 32 and an upper column tube member 33, a part of an inner-side piece 34b corresponding to an outer-side piece 34c is curved toward the outer-side piece 34c, thereby making the buckling adjusting part 35 being extended up to the vicinity of a folded part 34a. After that, similarly to the case of the steering column tube 11 of the first embodiment, the energy absorbing plate 34 in which the buckling adjusting part 35 has already been formed is mounted to the lower column tube member 32 and the upper column tube member 33. The other construction of the second embodiment is identical to that of the first embodiment.

According to the steering column tube 31 of the second embodiment, since the buckling adjusting part 35 has been formed in advance in the energy absorbing plate 34, the effect approximately identical to that by the steering column tube 11 of the first embodiment can be obtained. In addition, the pre-press being adopted in forming the

buckling adjusting part 35 may dispense with a consideration, needed in the case of the first embodiment, in which a dimensional deformation of the steering column tube 11 in a longitudinal direction must be unavoidably executed because of the pre-compression. For this reason, it is made easier to design the steering column tube 31.

In the first embodiment, although the guide part 12b is formed at the upper end of the lower column tube member 12 in order that the upper column tube member 13 can be smoothly slided, the guide part 12a is not always limited to such a formation. As shown in Fig. 9, for example, it may be also accepted that the upper end part 12a of the lower column tube member 12 is partially swelled outwardly along the circumferential direction, thereby forming a ring-shaped guide part 12c.

Furthermore, an approximately cylindrical spacer collar (not shown) may be also fixed to the outer periphery of the upper end part 12a of the lower column tube member 12 so that the outer peripheral face of the spacer collar is arranged to become slidably in contact with the inner peripheral face of the upper column tube member 13.

In the above embodiments, although the upper end part 12a of the lower column tube member 12 is inserted into the lower end part 13a of the upper column tube member 13, it may be also accepted that the lower end part of the upper

column tube member is inserted into the upper end part of the lower column tube member and the energy absorbing plates are disposed between the upper end part and the lower end part.

Although the present invention has been described and illustrated in detail, it is clearly understood that the same is by way of illustration and example only and is not to be taken by way of limitation. The spirit and scope of the present invention should be limited only by the terms of the appended claims.

WHAT IS CLAIMED IS:

1. A steering column tube for a motor vehicle, which includes:

(a) a first column tube member having a first cylindrical end part;

(b) a second column tube member having a second cylindrical end part into which said first cylindrical end part is slidably inserted; and

(c) a plurality of flexible energy absorbing plates which are disposed along a circumferential direction between said first cylindrical end part and said second cylindrical end part with intervals being left therebetween, each of said energy absorbing plates including:

(1) an inner-side piece which is disposed on an outer peripheral face of said first cylindrical end part along an axial direction of said steering column tube, and has an end fixed to said first cylindrical end part and another end disposed in said second cylindrical end part:

(2) a folded part, extended from said another end of said inner-side piece, which is turned up outwardly into a U-shaped state;

(3) an outer-side piece, extended from a top end of said folded part, which is disposed on an inner peripheral face of said second cylindrical end part along said axial direction of said steering column tube and has a top end

fixed to said second cylindrical end part; and

(4) a first buckling adjusting part being formed by deforming partially said inner-side piece in said second cylindrical end part such that said inner-side piece swells partially toward said outer-side piece.

2. A steering column tube of Claim 1, wherein said first buckling adjusting part is in contact with an outer-side piece.

3. A steering column tube of Claim 1, wherein said energy absorbing plate further includes a second buckling adjusting part being formed by deforming partially an outer-side piece between said first buckling adjusting part and said folded part such that said outer-side piece swells partially toward said inner-side piece.

4. A steering column tube for a motor vehicle mounting a steering wheel to a car body, which includes:

(a) a lower column tube member having a cylindrical upper end part, said lower column tube member being fixed to said car body;

(b) an upper column tube member having a cylindrical lower end part whose diameter is larger than that of said upper end part of said lower column tube member, and slidably inserting said upper end part of said lower column tube member into said lower end part of said upper column tube member, said steering wheel being provided at an upper

end side of said upper column tube member; and

(c) a plurality of flexible energy absorbing plates which are disposed along a circumferential direction between said upper end part of said lower column tube member and said lower end part of said upper column tube member with intervals being left therebetween, each of said energy absorbing plates including:

(1) an inner-side piece which is disposed on an outer peripheral face of said upper end part of said lower column tube member along an axial direction of said steering column tube, and has a lower end fixed to said upper end part of said lower column tube member and an upper end disposed in said lower end part of said upper column tube member:

(2) a folded part, extended from said upper end of said inner-side piece, which is turned up outwardly into a U-shaped state;

(3) an outer-side piece, extended from a top end of said folded part, which is disposed on an inner peripheral face of said lower end part of said upper column tube member along said axial direction of said steering column tube and has a top end fixed to said lower end part of said upper column tube member; and

(4) a first buckling adjusting part being formed by deforming partially said inner-side piece in said lower end

part of said upper column tube member such that said inner-side piece swells partially toward said outer-side piece.

5. A steering column tube of Claim 4, wherein said first buckling adjusting part is in contact with an outer-side piece.

6. A steering column tube of Claim 4, wherein said energy absorbing plate further includes a second buckling adjusting part being formed by deforming partially an outer-side piece between said first buckling adjusting part and said folded part such that said outer-side piece swells partially toward said inner-side piece.

7. A steering column tube of Claim 4, wherein said lower column tube member further includes a cylindrical guide part at an upper end side of said upper end part, and an outer diameter of said guide part is approximately equal to an inner diameter of said lower end part of said upper column tube member.

8. A steering column tube of Claim 4, wherein said lower column tube member further includes a ring-shaped guide part being formed by swelling partially said upper end part of said lower column tube member outwardly along a circumferential direction.

9. A steering column tube for a motor vehicle, substantially as hereinbefore desribed with reference to the accompanying drawings.

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